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Draft GI Planning Assignment

Overcoming Barriers to Green Infrastructure at the Local Planning Level

Executive Summary

Local planning, zoning, and construction codes are three of the most powerful tools that communities have to shape their surroundings. They help drive where and how development and redevelopment occur, and as such, have a large impact on factors such as air and water quality and community livability. Whereas the planning process helps set community goals and the pattern of development, zoning drives the location, size, configuration, and density of neighborhoods, roads, housing designs, parks, and other community features. The underlying construction codes help to insure that a minimum level of safety for buildings, roads, and other infrastructure is met.

These tools have gained strength in the U.S. over the past century, and have helped shape and reshape our counties, cities, towns, and villages. Most often, changes occur in the planning process in response to new challenges and evolving community values, or when shortcomings are revealed in current processes. Some of the most critical challenges facing communities today include intense pressures brought about by urbanization, population growth, aging infrastructure, energy and water use, and climate change. As such, concepts such as sustainable development and green infrastructure have edged their way into the planning vernacular.

> For many localities, changes necessary to encourage or accommodate the presence of green infrastructure via local planning policies and zoning codes have not yet caught up, restricting what can be implemented on the ground.

Green infrastructure is a stormwater management approach that mimics the natural hydrologic cycle to capture and treat runoff where it falls. While originally developed to help communities meet their stormwater regulatory requirements, its benefits extend beyond riparian habitat and water quality protection. Green infrastructure helps balance the need for new growth and development with improved flood mitigation and air quality management, public safety and health benefits, and other social and economic enhancements. Where planning, zoning, and building processes permit, green infrastructure practices can be woven into the design and construction of public and private properties, streets, trails, and schools as new and/or retrofit projects in order to create a network of green practices within a community.

Improvements in our understanding and application of practices like green roofs, permeable pavements, and water reuse systems – in addition to a local desire to create more sustainable, robust communities – have allowed green infrastructure to take hold in an increasing number of U.S. cities. Community specific goals related to increased tree cover, better site design, on-site stormwater management, reduced impervious surfaces, and green streets have crept into comprehensive and master plans. Coupled with changes to zoning and specialty codes, developers and engineers can then freely incorporate such practices into their designs.

As with any new concept, for many localities, the changes necessary to encourage or accommodate the presence of green infrastructure and low-impact development have not yet caught up, restricting what can be implemented on the ground. Quite often, builders and developers are hindered by outdated codes and standards that emphasize traditional stormwater management and development practices that encourage excess imperviousness. Implementing the simplest of practices may require variances to be filed, leading to increased costs and construction delays. Even when granted, traditional stormwater controls may still be obligated to be put into place, duplicating efforts.[1]

The cost of outdated codes and standards extends beyond that of the environment. An increasing number of studies are revealing the social and financial costs of practices that increase per capita impervious surfaces and encourage disperse development. This document is intended to help communities gain a better understanding of the relationship between green infrastructure, sustainable development, and the planning process. It provides an understanding of the history and progression of modern planning efforts towards green infrastructure, some common approaches and guidelines for developing and achieving program goals and objectives, and examples and studies documenting how cities have successfully incorporated sustainable planning practices. It is organized as follows:

- An introduction to three land use planning tools – comprehensive planning, zoning, and development codes
- A discussion on green infrastructure, sustainable design, and the impacts of conventional codes and regulations;
- The public benefits of green infrastructure;
- Six key elements of incorporating green infrastructure into local planning activities; and
- The implementation of green infrastructure practices into landscaping, parking, and street design standards.

I. Introduction to Land Use Planning Tools

Community and neighborhood development in the U.S. is largely controlled by the land use planning process. Communities often utilize long-term planning documents such as general plans, master plans, and neighborhood plans to identify overarching community goals, policies, and strategies that direct future growth. Comprehensive general plans are used to set forth a community's goals, policies and programs for land use and development. Master plans occur at a range of scales – with neighborhood and/or small area master plans being the smallest – and are also used to target specific issues such as recreation, environmental, or transportation planning.

Zoning and construction codes specify the current legal requirements to which development and redevelopment must adhere. Zoning ordinances are laws used to implement the types of land uses recommended in a planning document, though oftentimes zoning changes are enacted without the use of a long-term planning document. Zoning ordinances define the density, available building area, and green space coverage for different zoning categories and provide guidelines for the physical configuration and the permitted uses. Construction codes provide additional guidelines for the construction of buildings, roads, parking lots, plumbing and drainage, fire and safety, and other community features in order to ensure that all development adheres to a minimum level of safety and construction requirements. Most often, such codes are based upon major national standards and guidance documents that may be modified by states and local jurisdictions to meet the needs of local communities. The components of both these tools can have a substantial direct and indirect impact on air and water quality.

Every state has zoning enabling legislation for municipalities, and many also have zoning enabling legislation for counties. For example:

- Of the 50 largest U.S. cities, all but three have a comprehensive plan[2] and all except one (Houston, TX) have adopted zoning ordinances.[3]
- In New York, the majority of its villages, towns, and cities utilize comprehensive planning (89, 71, and 100 percent, respectively) and zoning (66, 71, and 92 percent, respectively) tools to direct land use. Counties, which do not have the ability to enact zoning, were given the ability to develop comprehensive plans in 1997. As of 2008, 53 percent of the state's counties have written comprehensive plans.[4]
- In Pennsylvania, 52 percent of all municipalities have a comprehensive plan and 57 percent have zoning. When evaluating just those municipalities that have 10,000 residents or greater, however, this number jumps significantly – to 97 percent with comprehensive plans and 100 percent with zoning ordinances in place. Because precedence is given to municipal zoning over county zoning, very few counties (12

percent) have a zoning ordinance. Nearly all counties, however, have written comprehensive plans (97 percent).[5]

- A representative sampling of cities and counties in the state of Washington completed in 2005 found that all had either adopted a comprehensive plan or had one under preparation. In addition, zoning ordinances in these cities and counties were in conformance with their comprehensive plans.[6]

Land use plans and the underlying jurisdictional codes often take a substantial time to develop and revise, and the process of incorporating new concepts such as "smart growth" or "green infrastructure" can often be slow. Comprehensive plans are typically reviewed on a 10 year cycle, and there is often a two-year lag between the development of model codes and their modification and adoption at the local level. It is not uncommon, then, for long-term planning and zoning and code adoption to become out of whack with one another.

Plans become outdated, and zoning changes may be made without the presence of comprehensive plans. For example, in a separate survey of New York State municipalities conducted in 2007, it was found that, while zoning regulations are required to be in agreement with local comprehensive plans, only 22 percent of respondents felt there was complete consistency, while 54 percent though it was mostly consistent. One reason was that many plans were considered "seriously outdated" or in need of revisions.[7] Coupled with zoning and specialty codes that can act as deterrents to better growth management, developers are limited in their ability to bring new ideas such as green infrastructure to the marketplace. This finding is consistent with other studies.[8, 9, 10] That being said, there has been an increased focus in recent years on long-term, comprehensive planning on both the local and state level that provides an opportunity to build upon planning efforts and updates to zoning and specialty regulations to implement more flexible solutions to tackle today's community challenges.[11, 12]

Historical Perspective

Modern planning and the emphasis on comprehensive zoning grew out of efforts in the 19th century by city reformers seeking to make widespread improvements in the conditions of their cities. In the 1920s, the Standard Zoning Enabling Act (SZEA) and the Standard City Planning Enabling Act (SCPEA) led to a proliferation of local planning and zoning activities as state after state enacted enabling legislation.[13] The SZEA, which was eventually adopted by all 50 states, viewed comprehensive planning as necessary to reduce the chance of being declared unconstitutional, as well as to provide a more objective analysis of the land it affected. The SCPEA, which was adopted by 35 states by 1930, was intended to complement the SZEA, and allowed cities to adopt plans largely focused on public works issues such as mapped locations of future streets and parks.[14]

While the institutional structures of the acts are still largely followed today, some of the components have changed in order to overcome criticisms. For one, planning was allowed but not required under the SCPEA, and no fundamental planning elements were defined. This resulted in haphazard planning efforts. The SZEA required conformance with a comprehensive plan, but did not define what a comprehensive plan was, nor require it to be a separate

document. All of this served to minimize the role of long-term planning. But by the 1960s, a process by which general plans were prepared, adopted, and periodically updated began to emerge, and by the 1970s, a stronger case for mandatory, binding comprehensive planning was being made.[15]

In addition, the acts were written in an era where land use issues were largely the problem of urban communities. Concerns principally focused on controlling the height and setbacks of buildings and keeping residential areas separate from incompatible or noxious uses via single-use zoning districts.[16] Issues such as population growth, the increasing reliance on cars and emergence of new transit routes, the impact of technology on lifestyles, natural resource protection, and, more recently, concerns over global warming, energy usage, clean water, and cost-effective strategies to address aging infrastructure were not yet present or as prevalent. And, while separating residential areas from potentially noxious land uses is still important, such goals must be weighed against the needs to place uses where they are most efficient and the need to create mixed-use environments where alternative modes of transportation and lively urban environments can exist. Today's local leaders are discovering that their own zoning regulations and specialty codes often conflict with the desire to address these changing circumstances and community values. [17]

II. Green Infrastructure and the Urban Environment

"Green infrastructure" is a term often used to describe stormwater management techniques that use or simulate the actions of natural systems to capture rainwater as near as possible to where it falls. Over the past few decades, this approach has increasingly gained acceptance because of its ability to slow and reduce the amount of water and pollutants entering nearby streams or underground stormwater systems while also improving a community's aesthetics and providing other environmental, social, and economic benefits.

In New York City, for example, the New York New Housing Legacy Project held a competition to design a vacant 60,000 square-foot site in the South Bronx as the future location of a public housing project that combined the most advanced green design concepts with high-quality architecture. Its goal was to set a new standard and competitive model for affordable housing design and development that can be replicated in New York and across the country and to provide affordable, sustainable, high-quality homes for participating Bronx families. The end result was Via Verde – a 222-unit mixed-income housing development. Here, the application of green infrastructure went well beyond stormwater management to designing a healthy place to live. For example, the 40,000 square-foot terraced roof planted with garden plots and fruit trees was placed directly in view of the development's fitness center to encourage a destination for walkers. The communal garden plots allow tenants to grow their own food. [18]

Conventional codes and regulations can create barriers to green infrastructure and sustainable design, often unintentionally. For example, traditional parking lot dimensions are set using

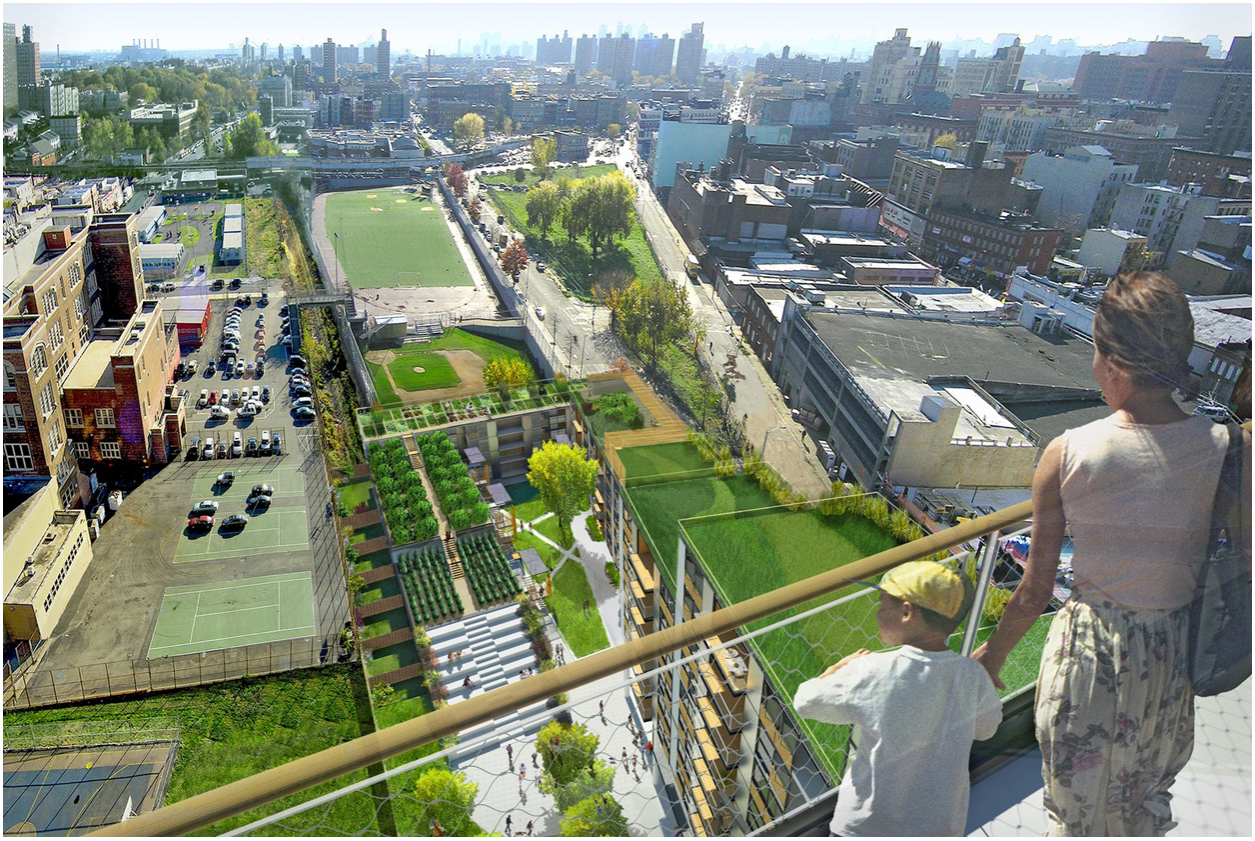

Figure 1. Rendering of *Via-Verde—The-Green-Way*, winner of a New Housing New York Legacy Competition to develop a vacant site in the South Bronx with a mixed use site that includes low-income housing and a series of connected green rooftops that are used to harvest rainwater, grow fruits and vegetables, and provide open space for residents. The $99 million development held its grand opening in June 2012.

minimum parking lot standards which favor larger, parallel parking spaces over angled ones and minimize the use of landscaped features. Parking management practices that establish maximum and not minimum parking lot standards, reduce parking stall widths, encourage shared parking, and establish landscaping requirements to encourage shading can add up to major savings for developers and businesses owners who are faced with the costs of providing an overabundance of parking.[19, 20]

One of the difficulties lies in the fact that the pace of development of new technologies and construction materials has advanced faster than the codes themselves. The focus on walkable communities, ecological designs, and green building materials don't mesh well with the often prescriptive code requirements for fire safety,[21] as well as plumbing, building, and other construction codes. New codes quickly become outdated. The end result is less than optimal codes that restrict the use of green infrastructure and low impact development and are in conflict with other community criteria.

Where permitted, however, green infrastructure practices can be woven into the design and construction of public housing and other public buildings, private properties, streets, and

schools in order to create a network of green practices within a community. The development of Via Verde coincided with a Department of City Planning Green Codes Task Force to remove zoning impediments to green building features that promote stormwater detention and energy efficient building envelopes, and reduce carbon emissions. In it, stormwater management equipment was added to a list of permitted rooftop obstructions allowed to exceed height limits. A Citywide zoning text amendment was adopted in April 2012.[22]

Improvements in our understanding and application of green roofs and other green infrastructure practices such as permeable pavements, rain gardens, and water reuse systems have allowed such practices to take hold in an increasing number of cities. Community specific goals related to increased tree cover, better site design, on-site stormwater management, reduced impervious surfaces, and green streets have crept into comprehensive and master plans. Coupled with changes to zoning and specialty codes to accommodate their presence, developers and engineers can then freely incorporate such practices into their designs.

III. Public Benefits of Green Infrastructure

Land-use planning often influences community attributes such as neighborhood and traffic density, drinking water safety, and water, air, noise, and light pollution. However unintentional, conventional land-use planning codes pose barriers to the positive public benefits of integrated land-use planning and green infrastructure. These benefits include:

- **Better Water Quality / Pollution Prevention.** Many conventional planning and zoning practices allow only for the use of traditional, end-of-pipe stormwater solutions. Implementing green infrastructure allows for site-specific solutions to capture, store, filter, and infiltrate stormwater at the source, reducing point source pollution and improving the water quality of local streams, rivers, and water bodies. Improved water quality opens doors for recreational activities such as swimming and fishing.
- **Community and Economic Development.** Incentivizing and promoting infill and mixed-use development can reinvigorate a downtown area suffering from high vacancies and slow business.[23] Ensuring a proper density in suburban and urban areas develops a sense of place, fostering neighborhood connectivity and walkability.[24] Parks and public spaces built using green infrastructure practices can help educate the community on sustainability issues and showcase treatments that can be implemented at home. Regulations surrounding stormwater fees can be retooled to reward residents and local business owners for treating stormwater on site.
- **Improved Public Safety and Health.** As one of the main drivers of local planning and zoning codes, public safety and health can be enhanced through green infrastructure. Context sensitive street and parking lot standards help improve multimodal transportation safety and allow space for green infrastructure technologies.[25] Improved

sidewalks and curb extensions provide safe pedestrian connections to neighborhood resources.

- **Climate Change.** Green infrastructure has the potential to help cities and towns adapt for climate change by reducing the urban heat island effect and stormwater runoff through increasing vegetative surfaces and tree cover, increasing infiltration, and decreasing impervious surface. A 2007 study of Greater Manchester, UK, modeled the potential impact of adding an additional 10% of green infrastructure in high-density residential areas and town centers to moderate the impact of climate change found that it offered "significant potential" to moderate increases in summer temperatures.[26] Another study on the impact of green roofs found that their capability to sequester carbon is so significant that, in an urban area of 1 million people, replacing traditional roofs with green roofs would be as effective as removing more than 10,000 mid-sized SUVs or trucks off the road each year.[27]
- **Community Resiliency.** Green infrastructure helps create more resilient communities that have a greater ability to bounce back from adverse conditions, whether due to a natural disaster or economic decline. Utilizing sustainable stormwater management technologies can reduce flooding in flood-prone areas, and rain barrels and cisterns can store water during drought conditions. In the event of adverse economic conditions, residential property values are generally higher when located adjacent to green infrastructure amenities (parks, trails, bike routes, etc.) by two to five percent.[28]
- **Accessibility and Mobility.** An integral part of green infrastructure is pedestrian accessibility and mobility. Current codes require ADA compliance, and green infrastructure takes it a step further. By developing trails, complete streets, curb extensions, and bike routes, green infrastructure connects more people to more destinations that might otherwise only be accessible via automobile. For destinations outside of the local community, promoting public transit such as bus routes, streetcars, and high speed rail, green infrastructure works to connect more people to more destinations without the need for automobile ownership.

IV. Key Elements for Incorporating Green Infrastructure into Local Planning Activities

A recently completed study in Virginia of 41 cities and counties identified local codes and ordinances as the greatest impediment to green infrastructure.

Conventional planning and zoning practices don't typically address the impact of development on water quality but instead limit the ability to incorporate green infrastructure practices into the design of local development or redevelopment projects. For example, a recently completed study in Virginia of 41 cities and counties identified local codes and ordinances as the greatest impediment to how extensively green infrastructure practices are applied.[29] However, an increasing number of

localities are taking steps to remove barriers and make implementation easier. When considering how to incorporate green infrastructure can better be integrated into local community planning efforts, specific steps can be taken to make planning, zoning, and code development more effective water quality tools:

- **Conduct pilots** to allow for further understanding and acceptance of green infrastructure technologies at the local level. Pilot projects also allow departments to work together to identify possible road blocks – such as incompatible codes or safety concerns.
- **Remove obstacles** to green infrastructure design by reviewing and amending planning documents, zones, or codes, when necessary.
- **Create incentives** to motivate developers and property owners to implement green infrastructure technologies.
- **Set standards** based on performance criteria for new development or redevelopment, as well as the underlying construction & specialty codes, to encourage the adoption of new control strategies.
- **Identify goals, policies, and strategies** that can be interwoven into long-term planning documents or updates to further define how the community envisions green infrastructure fitting into their overall objectives. Describe how water infrastructure systems relate to growth and sustainable planning, and make green infrastructure an integral part of community and neighborhood development.

V. Incorporating Green Infrastructure Practices into Codes and Ordinances

The implementation of green infrastructure practices has benefited tremendously from advances in technologies, as well as policies and incentives promoting specific green infrastructure practices, such as ***green roofs*** (e.g., Chicago, IL, Washington, DC, Portland, OR, and New York, NY) ***impervious surface reductions*** (e.g., Portola Valley, CA's impervious limits on properties; Philadelphia, PA's stormwater management fee reductions for reduced imperviousness) and ***rain gardens*** (e.g., Washington's Puget Sound Region's 12,000 Rain Gardens project). Successful implementation, however, most often requires changes in codes and ordinances in order to allow developers, homeowners, and others to fully integrate such practices.

Additional Resources for incorporating green infrastructure practices into local planning efforts:

- US EPA's ***Green Infrastructure Municipal Handbook Series***
- US EPA's ***Green Parking Lot Resource Guide***
- American Rivers' ***Local Water Policy Innovation***
- US EPA's ***Water Quality Scorecard***
- Center for Watershed Protection's ***Code and Ordinance Evaluation Worksheet***
- Natural Resources Defense Council's ***Rooftops to Rivers II***

Such changes are on the rise. An increasing number of municipalities across the U.S. have updated their stormwater and land use ordinances to include green infrastructure and smart growth practices. Green infrastructure is also being integrated into standard building practice via existing or never versions of the International Green Construction Code, the International Association of Plumbing and Mechanical Officials' Green Code Supplement, and the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®).[30] For cities or localities that have not yet undergone an update but would like to, code and ordinance review toolkits such as those available from EPA and the Center for Watershed Protection are available to help guide the process.

The need for collaboration and a focus on performance-based versus prescriptive code criteria has been cited by multiple sides of the code community as necessary steps for developing more socially optimal codes that reduce the environmental impact of development while not adversely impacting public health and safety.[31, 32] For example, the National Association of State Fire Marshals has developed an advisory working group to work through issues from a fire safety perspective related to sustainable development and construction practices,[33] and in 2007, the EPA, the Congress for the New Urbanism, and fire marshals from across the country began partnering together on an Emergency Response & Street Design Initiative.[34] At the local level, while the process of updating codes to ensure that green infrastructure practices do not conflict with other construction and specialty codes can be long, up front collaboration is rewarding in the long-term. For example, Portland, Oregon's now-complete Downspout Disconnection Program started out as a two-year pilot to allow the city's time to identify and address any concerns related to discrepancies with local building and plumbing codes, fire codes, and setbacks, amongst other things, and helped the city build a highly successful program.[35]

The examples and information below are intended to offer guidance on how local codes and ordinances can be modified to encourage green infrastructure practices for greater on-site stormwater management, as well as other identified community benefits. Examples have been broken down into three sections for ease of use: landscaping, parking, and streetscapes. The documents listed above provide additional examples and suggestions on how to better incorporate on-site stormwater management practices into the land development process.

Landscaping and Water Conservation

Background

The first U.S. landscape ordinance dates back to the 1700s, when the Pennsylvania Shade Tree Law was enacted to establish tree planting standards for early settlements around Philadelphia. In the late 1890s and early 20th Century, the City Beautiful Movement took hold, encouraging the beautification of metropolitan areas. It wasn't until the late 1960's – early 1970's, however, that contemporary landscape ordinances first appeared in order to require minimum standards for incorporating landscaped areas into the built environment. As Americans began to prosper,

urban populations and development grew, requiring the need to preserve and incorporate natural features.

Landscape ordinances help to establish buffers around sensitive environmental features, require plantings along streets and buildings, require parking lot screens, and set minimum standards for tree canopies and, on occasion, on-site stormwater management. Such ordinances typically fall into one of three categories: 1) *tree ordinances*, which focus on municipal tree care; 2) *post-construction landscape ordinances*, which regulate the planting and landscape requirements on building sites; and 3) *comprehensive landscape ordinances*, which restrict the clearing of land and preservation of trees and other natural features on site prior to development.[36]

Green infrastructure-friendly standards

While beautification was one of the original drivers for landscape ordinances, issues such as increased imperviousness and the urban heat island effect, increased heat, noise, air and water pollution, and community livability have been identified as regulatory drivers. Water conservation has also become an increasingly key issue in communities in the Western U.S., in particular, where water consumption is higher. Such issues began appearing in force starting in the 1990s.[37, 38] Planning efforts such as Chicago's Green Urban Design Plan[39] are pushing these efforts even further by focusing on encourage the use of green infrastructure, improving the environmental performance of development sites, and strengthening sustainability standards.

Figure 2. The Lane Community College Health and Wellness Facility in Eugene, OR.

Interest in green roofs – *rooftop landscapes* - has also been on the rise -- fueled by their proven ability to reduce stormwater runoff, energy consumption, and the urban heat island effect, as well as play an integral role in climate change strategy. In 2011 report by the US General Services Administration, green roofs were identified as one of the best ways to address stormwater runoff in areas with high-density development due to their ability to reduce runoff rates by 65%, to extend the time it takes precipitation to leave a site by up to 3 hours, to buffer the effects of acid rain, and, in areas with combined sewers, their ability to reduce the frequency of combined sewer overflows.[40] Recent research has also shown that green roofs have the capability of sequestering large amounts of carbon. Replacing traditional roofing

materials in an urban area of about one million people, for example, would capture more than 55,000 tons of carbon -- the same effect as removing more than 10,000 mid-sized SUVs or trucks off the road a year.[41] While green roof systems' popularity and use are increasing, the previous lack of uniform standards and codes has often been cited as an impediment to quality assurance managers in the building industry recommending green roofs for their projects.[42]

A shift towards more sustainable landscape requirements often requires modifications to existing codes and ordinances, where they exist, or adoption of new regulations, where they do not. Some specific examples of how landscaping and zoning codes can better incorporate the goals of green infrastructure and sustainable communities are as follows:

- Explicitly identify the use of green infrastructure and landscapes to improve water quality, as well as other benefits identified by the community, as an intent and purpose of zoning
- Modify language in the landscaping ordinance, where necessary, to ensure that landscaping is designed in keeping with green infrastructure stormwater management principles, and that screening areas can also function as stormwater management features
- Remove potential impediments to the development of green roof or rainwater harvesting systems on new and existing buildings by clarifying that such systems should not count against a building's Gross Floor Area or Height Restrictions. Modify the definition of open space to include roofs, allowing accessible green roofs to count as open space
- Exempt rain gardens and bioretention cells from high weed and grass ordinances
- Include the use of stormwater best management practices in landscape design plans.
- Consider the use of a simple points-based landscape factor, such as the Seattle, WA, green area ratio or the City of Fife, WA, green factor to incorporate the use of green infrastructure into development and redevelopment projects
- Establish maximum percent impervious cover limits for various zoning districts in the zoning code, while defining the use of landscaped areas and green roofs to allow for stormwater management
- Ensure that the landscaping ordinance allows for native landscaping, drought-tolerant/water-efficient landscaping and natural lawns, and prevents the use of exotic invasives. Consider including a list of recommended and prohibited plantings, species diversity requirements, minimum planting sizes, maintenance requirements, and restrictions on the use of pesticides, herbicides, and fertilizers
- Modify regulations to include a tree protection ordinances with tree replacement provisions
- Apply clearing and grading requirements to all land disturbance activities over a certain size or volume, even when other permits are not necessary. Restrict clearing to the minimum area required for building and roadway footprints, construction access, and safety setbacks

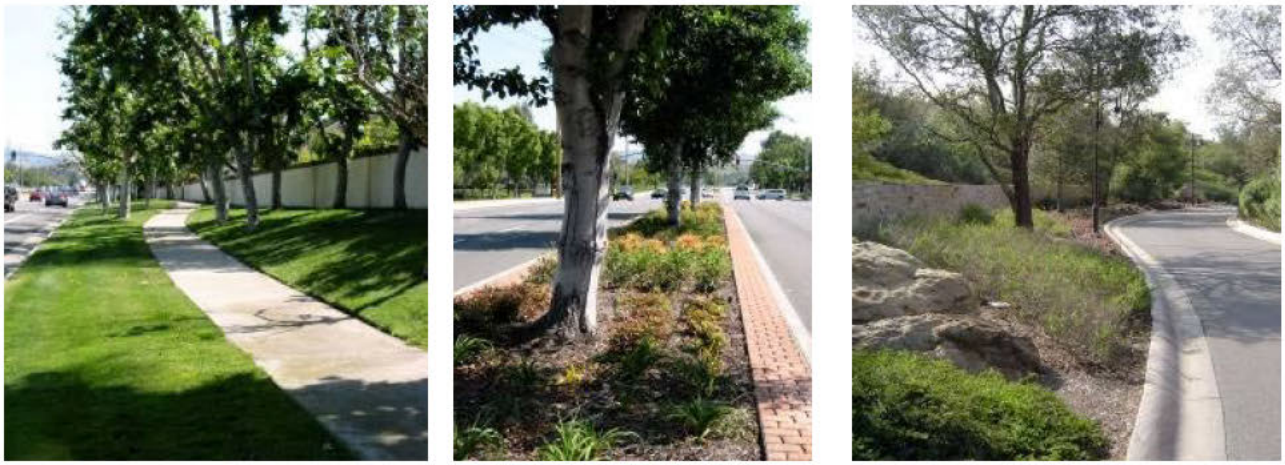

Figure 2. Landscaping practices in the Irvine Ranch Water District in California have shifted over time, as a result of a Sustainable Landscape Ordinance that was implemented in 1991. The pictures from left to right show a shift in landscaping patterns circa the 1970s, 1990s, and 2000s.

Studies show that the implementation of stronger policies and landscape regulations and incentives can have a direct impact in the ability and likelihood of developers to follow greener development practices. In Chicago, IL, for example, the city estimates that an additional 110,000 trees were planted between 1991 and 2007 due to a 1991 landscape ordinance requiring new or substantially renovated buildings to incorporate landscaping into their plans. This ordinance was amended in 1999 to include requirements for landscaped parking lot islands.[43]

Not only do such regulations have an impact in the ability and likelihood of developers to implement greener practices, but they are also being shown to have positive results. For example, in a study of the impact the presence (or lack of) more restrictive landscape regulations on two developments in Houston with similar pre-development ecological conditions, it was shown that the one with more restrictive landscape regulations fared better ecologically over the long-term.[44] In California, a study on the impact of a 1991 sustainable landscape ordinance in the Irvine Ranch Water District, CA, to shift the community toward water-efficient plants also showed positive results, with more than a 30% drop in water usage as compared to nearby developments not affected by the regulations.[45] By further tailoring the use of landscape ordinances to accommodate on-site stormwater management, even greater benefits could be achieved.

The implementation of stronger policies and landscape regulations and incentives can have a direct impact in the ability and likelihood of developers to follow greener development practices.

For those practices where there is still some uncertainty on the part of developers or, in the case of green roofs, the initial cost is greater, coupling clearer standards and guidelines with incentives (e.g., density bonuses) or other requirements (e.g., required for city financial assistance) can move integration forward. In the case of Chicago, IL, for example, all new city

buildings are required to have a partial green roof. In addition, developers receiving financial or zoning assistance from the city must include either a cool roof or vegetated roof. As a result, Chicago has added an abundance of green roofs to its city skyline. Greater supply has also helped the cost of installation go down, from an average of $25 to $15 per square foot.[46]

Parking

Background

Providing off-street parking is standard practice for residential and commercial development. Minimum parking requirements which require developers to build at least a minimum designated number of off-street parking spaces entered into local zoning regulations in the mid-1900s as the automobile's popularity increased and the demand for curbside parking began to exceed availability. In 1964, a survey of 76 cities found that 17% had minimum parking requirements. In a follow-up study five years later, it was found that an additional 41 of the original 76 cities studied had implemented minimum parking requirements – a 54% increase. Today, it is hard to find a zoning ordinance where minimum off-street parking requirements for all land uses do not exist.[47] The result is that parking areas have become a prominent feature of the landscape. For example, a detailed study of off-street surface parking in Illinois, Indiana, Michigan, and Wisconsin published in 2010 identified an average of 2.5 to 3 non-residential parking spaces per vehicle.[48] Providing parking does not come cheap, however. In 2009, average construction costs for off-street parking facilities were approximately $5,000 per space, while the average structured parking space was four times more.[49] Overall, parking represents about 10% or greater of typical building development costs.[50]

Parking requirements are most often established for specific land uses by either utilizing generic formulas or standards developed by the Institute of Transportation Engineers, or by adopting the standard requirements of neighboring cities. Such parking standards, however, are typically based on maximum demand and result in overly large parking lots or structures that increase stormwater runoff, have limited aesthetic appeal, and do not reflect a community's real parking needs. Generous parking formulas have also been found to have a negative effect on factors such as housing affordability, transit-oriented development, and traffic, and tend to encourage sprawl and commercial strip development.[51] In Oakland, California, the establishment of a minimum parking requirement in 1961 was shown to raise construction costs per dwelling unity by 18%, decrease housing density by 30%, and decrease land values by 33%.[52] As a result, the concern has shifted from that of too little supply to better management of the existing supply.

Green infrastructure-friendly standards

Figure 2. A parking lot in downtown Tampa, FL, designed with green infrastructure practices

While zoning practices that encourage excess parking and restrict low impact development practices are still the norm, there has been an increasing desire in urban US cities to use parking lands more efficiently.[53] Such strategies may include establishing maximum parking requirements; allowing for shared or off-site parking; and improving facility design by reducing impervious surfaces and adding landscaped areas that serve double duty as stormwater management facilities.

Green infrastructure-friendly parking standards reduce the size of parking lots while adding landscape areas that serve double duty as stormwater management facilities. The benefits of greener parking lots through better parking management are not just limited to stormwater management, however. In a case study evaluating the impact of reducing parking requirements at SAFECO Corporation's Seattle headquarters, it was estimated that reducing the amount of parking built providing the company with an estimated $230,000 in savings per year.[54]

Rather than hurting businesses, placing restrictions on parking by eliminating parking minimums or using use market-rate parking pricing to better manage demand for parking can actually increase visitor turnover that helps local businesses. By increasing turnover and ensuring that spaces are available for customers, well-calibrated parking policies can increase patronage.

For example, in Seattle, the city extended metered parking hours from 6pm to 8 pm in mid-2011. In a study evaluating the impact of this change on Seattle restaurants, it was found that gross revenue increased by nearly 9% in a year-over-year comparison after the change took effect according to the Sightline Institute, a Northwest policy think tank.[55] Since 2000, the New York City Department of Transportation (NYCDOT) has been replacing unpriced commercial loading with paid commercial parking in order to improve curb access and reduce congestion. Results of a pilot in 2000 showed reductions in average parking durations from 160 to 45 minutes. Now, paid commercial parking covers most commercial parking spaces in Manhattan.[56]

Reductions in the urban heat island effect, improved air quality, and improved community aesthetics have been identified as key benefits to increased landscaping in parking lots.[57] In California, the energy crisis of the 1970s encouraged the adoption of tree shade ordinances requiring tree canopies in parking lots to reduce energy use. For San Francisco, CA, and Boston, MA, the desire to push transit first policies led to the need to establish maximum parking

requirements. It is important, therefore, to keep in mind the needs of the community as a whole when identifying what specific standards are most applicable.

Possible modifications to existing parking standards include the following:[58]

- Adjust parking demand formulas based on a study of local needs
- Eliminate minimum stall and parking lot requirements and/or establish maximum parking requirements
- Allow for shared parking facilities for two or more adjacent uses
- Require bike parking as part of new parking lots, and allow racks in the public right-of-way where space is available
- If establishing a maximum percent impervious in the zoning requirement of each zoning district, include the footprint of all structures, including parking lots, in the definition
- Require parking lots over a certain size, overflow parking, and pedestrian walkways to use pervious materials for a percentage of the parking lot
- Revise landscaping ordinances to require the planting of parking lot perimeters and interiors, to require shading from trees, and to integrate the absorption of parking lot runoff into landscape areas
- Ensure adequate tree protection from parked vehicles
- Ensure that grading and edge treatments of parking areas allow storm water inflow into areas designed as green infrastructure storm water management features
- Encourage green roofs on parking structures
- Encourage parking lot designs that serve multiple purposes

Street Design Standards

Background

Streets in older US neighborhoods, villages, and towns built prior to the 1940s reveal a narrower design pattern with shorter blocks, streets flanked by planting strips and sidewalks, and smaller curb radii to slow down turning vehicles. Streets were designed to meet the needs not just of cars, but of pedestrians. Beginning in the late 1940's, however, the emphasis on street design became geared more towards cars solely. Pavement widths widened, blocks became longer, curb radii increased, and sidewalks became infrequent.[59]

Recently, there has been a growing recognition of the multiple benefits traditional street patterns provided – such as safer pedestrian movement, improved community livability, and improved environmental performance. This awareness has been coupled with an increasing movement on the part of local transportation engineers towards more traditional, narrower streets. Such efforts, however, can often be hindered by existing code and practices.

Street standards for local roads are typically based on state mandates and guidelines from organizations such as the Institute of Transportation Engineers (ITE) or the American

Association of State Highway and Transportation Officials (AASHTO), whose primary focus is on moving cars – and not pedestrians, cyclists, mass transit users, or freight vehicles – as effectively as possible. More often than not, public streets are also required to provide on-street parking, requiring wider street widths.[60] Other public agencies that utilize the space either on or beneath the street (public works, solid waste, utilities) also have underlying standards that affect minimum street widths.[61] Fire and safety criteria set forth by the National Uniform Fire Code and International Fire Code, in particular, have been cited as one of the greatest impediments to narrower, greener, more pedestrian-friendly street designs.[62, 63]

Green infrastructure-friendly standards

Green streets are defined as transportation right-of-ways integrated with green infrastructure techniques such as narrower streets, pervious pavement, and bioretention cells to treat stormwater near its source while providing other community benefits.[64] While numerous obstacles exist, various municipalities are overcoming such barriers to allow for successful implementation.

Nationally, local street pavement standards typically specify 36 feet in width.[65] In the Baldwin Park neighborhood of Orlando, Florida, however, which was the site of a former Naval Training Center, the city successfully built a community with narrow streets, 20 to 22 feet in width, with a complete street grid with alleyways to allow fire trucks easy access from all directions. In Iowa City, Iowa, a residential development with streets three feet narrower that required "as an experiment" was so successful that city planners began working with city engineers and fire officials to develop new residential street standards allowing for streets 26 in width with parking only on one side. The newer standard was seen as a compromise by the planners, engineers, and fire officials who worked to put them together.[66]

Other successful green street implementations abound in places such as Portland, OR, San Mateo County, CA, and Seattle, WA. As such, there are an increasing number of local design standards in places that can serve as models for other cities bringing green streets into the mainstream.

Figure 3. Neighborhood green street in San Mateo County, CA

One important key for success is buy-in from a cross-agency, interdisciplinary team.[67] Another is buy-in on a wider scale from fire officials. In 2007, the EPA, the Congress for the New Urbanism, and fire marshals from across the country partnered on an Emergency Response & Street Design Initiative to release information on traffic calming, street design, and emergency response.[68] In addition, the National Association of State Fire Marshals released a document in 2010 which includes common concerns regarding fire truck access and response times where green streets are

employed, and possible solutions (e.g., roll-down curbs, drivable sidewalks, and permeable ground surfaces that can support the weight of fire trucks) that communities can employ.[69] National standards have also begun inserting ideas that are conducive to building smaller, more walkable streets. With the release of its 2004 Green Book, AASHTO has begun to place more emphasis on the joint use of transportation corridors for cars, pedestrians, cyclists, and mass transit.[70]

Numerous sections of the local codes and ordinances can affect street design, including Zoning, Traffic, Fire, Building, Landscaping, Planning, and Public Works Codes. When working to design new standards, below are a few key areas to address:

- Evaluate general plans to determine what minimum level of service (LOS) has been assigned to major streets. Such standards limit measures intended to reduce vehicle speeds and the narrowing of vehicle lanes to accommodate bike lanes and other modes of transportation
- Adopt a green streets policy that addresses stormwater, street trees, and/or other needs (safer crossways, bike access, etc.) as identified by the community
- Modify transportation and right-of-way improvement standards to emphasize the use of green infrastructure practices in streets and sidewalks, where appropriate and feasible
- Enact design guidelines or standards to serves as a guide for the design and planning of alley and street scape components within the right-of-way
- Investigate creative ways of working with fire, waste, and utility departments to build flexibility in the design of streets in order to create narrower streets and minimize the impacts on trees and other infrastructure elements
- Establish procedures (e.g., coordination amongst agencies) to minimize the impact of infrastructure during utility and street rehabilitation projects
- Adopt pedestrian/street connectivity standards that must be met for specified developments

VI. Conclusions and Recommendations

Local governments play a key role in the integration of green infrastructure practices into development or redevelopment projects. Green infrastructure practices such as rain gardens, pervious pavement, parking lot islands, and street trees are more readily included in construction projects when clear policies and regulations exist. When hindered by outdated standards, developers and builders are required to surmount additional hurdles which can quickly lead to increased costs and construction delays, making implementation too troublesome.

Many of the previous hurdles to the incorporation of green infrastructure practices – i.e., a perception of higher costs, and limited performance data – have been overcome. In fact, in many cases, the costs of implementing greener stormwater practices have shown to be less

than conventional practices.[71, 72] Where localities have modified lands use planning tools to enable developers to incorporate green infrastructure practices into the development process, the pace at which such practices have been implemented has been quicker. Updated policies and regulations, coupled with better outreach and technical assistance, will move implementation forward.

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